بسم الله الرحمن الرحيم

10/4/2017 lec د. عمرو مصا حمزة

* Radiation resistance G

$$R_{rad} = \frac{W_{rad}}{I_{rms}^2} = 20\pi^2\left(\frac{L}{\lambda}\right)^2 \ \Omega$$

$$R_{rad\,mono} = \frac{R_{rad}}{2} = 10\pi^2\left(\frac{L}{\lambda}\right)^2 \ \Omega$$

* Radiation intensity

U_{max}

$$U = r^2 \cdot \bar{P}_{av} = \frac{1}{2\eta}\frac{\omega^2\mu^2}{(4\pi)^2}\frac{I_o^2 L^2}{4}\sin^2\theta \quad W/Str$$

$$U_{max} = \frac{1}{2\eta}\frac{\omega^2\mu^2}{(4\pi)^2}\frac{I_o^2 L^2}{4} \quad W/Str$$

* Directivity

التبدلها ب ηB

$$D = 4\pi\frac{U_{max}}{W_{rad}} = \cancel{4\pi}\frac{1}{2\eta}\frac{\omega^2\mu^2}{16\pi^2}\frac{\cancel{I_o^2 L^2}}{4} * \frac{\lambda^2}{10\pi^2 \cancel{I_o^2 L^2}}$$

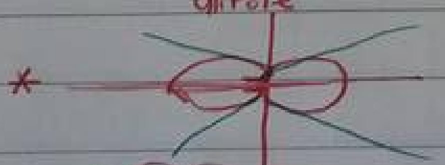
$$= \frac{\eta^2 B^2}{2\eta}\frac{1}{16\pi}\frac{1}{10\pi^2}\lambda^2 \qquad \omega\mu = \eta B$$

$$B = \frac{2\pi}{\lambda}$$

$$= \frac{120\pi}{2} * \frac{4\pi}{\lambda^2}\frac{1}{16\pi}\frac{\lambda^2}{10\pi^2} = \frac{120*4}{2*16*10} \qquad \eta = 120\pi$$

$$= 1.5$$

dipole



D = 1.5

E.plane

H-plane

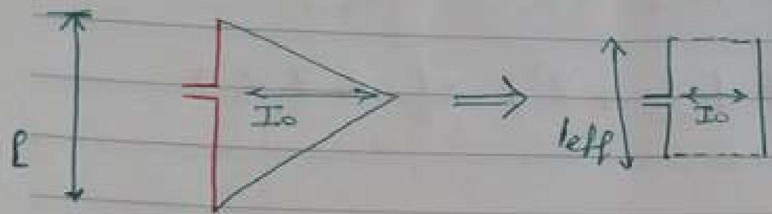
$D_{mono} = 1.5 * 2$

Mono Pole

D = 3

H.plane

* effective length l_{eff}



محول التيار

مساحة المثلث = مساحة المستطيل

$$\frac{1}{2} L I_o = l_{eff} I_o$$

$$\boxed{l_{eff} = \frac{L}{2}}$$

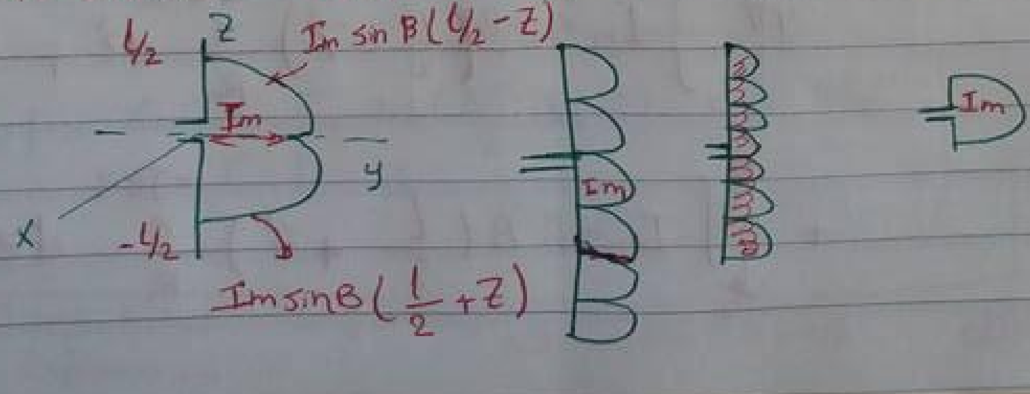
dipole

Mono Pole $\boxed{l_{eff_{mono}} = \frac{L}{4}}$

Long Dipole

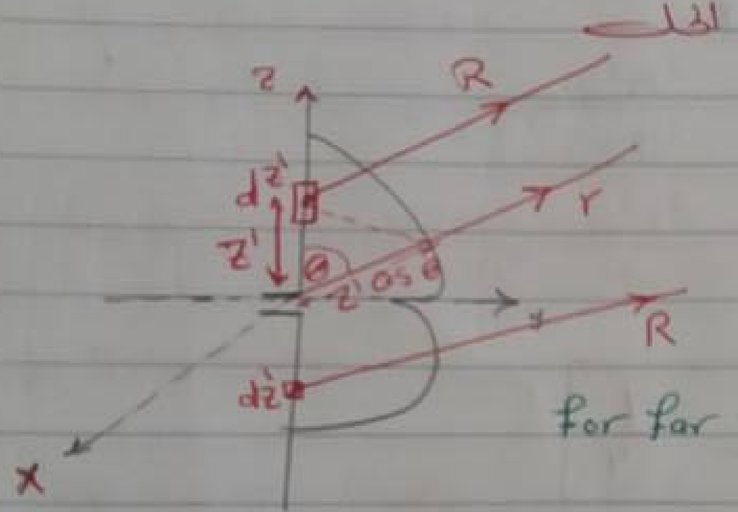
* The wire antenna (dipole) are Considered as open ends Transmission lines standing wave patterns along The antenna length.

* The Current Distribution along The long dipole is given by



$$I(z') = \begin{cases} I_m \sin B\left(\frac{L}{2} - z'\right) & 0 < z < \frac{L}{2} \\ I_m \sin B\left(\frac{L}{2} + z'\right) & -\frac{L}{2} < z < 0 \end{cases}$$

* Determine The Magnetic Potential Vector for long dipole



for far field

* $\frac{1}{R} \simeq \frac{1}{r}$

* $R \simeq r - z' \cos\theta$

$$A(x,y,z) = \frac{\mu}{4\pi} \int_{-L/2}^{L/2} I(z') \frac{e^{-JBR}}{R} \, dz'$$

$$A(x,y,z) = \frac{\mu}{4\pi} \left[\int_{0}^{L/2} I_m \sin B\left(\frac{L}{2} - z'\right) \frac{e^{-JBR}}{R} \, dz' + \int_{-\frac{L}{2}}^{0} I_m \sin B\left(\frac{L}{2} + z'\right) \frac{e^{-JBR}}{R} \, dz' \right]$$

$$A(x, y, z) = \frac{\mu I_m}{4\pi}\left[\int_0^{l/2} \sin\beta\left(\frac{l}{2} - z'\right)\frac{e^{-j\beta(r - z'\cos\theta)}}{r}\,dz'\right.$$

$$\left. + \int_{-l/2}^{0} \sin\beta\left(\frac{l}{2} + z'\right)\frac{e^{-j\beta(r - z'\cos\theta)}}{r}\,dz'\right]$$

لو طلب الصوره دي ثم الصوره النهائيه

$$\cancel{A_z = \frac{I_m}{\beta}}$$

مهم

$$\boxed{A_z = \frac{\mu}{2\pi}\,\frac{I_m}{\beta}\,\frac{e^{-j\beta r}}{r}\left[\frac{\cos\left(\frac{\beta l}{2}\cos\theta\right) - \cos\frac{\beta l}{2}}{\sin^2\theta}\right]}$$

① $E_\theta = j\omega A_z \sin\theta$

$$= \frac{j\omega\mu}{2\pi}\,\frac{I_m}{\beta}\,\frac{e^{-j\beta r}}{r}\left[\frac{\cos\left(\frac{\beta l}{2}\cos\theta\right) - \cos\frac{\beta l}{2}}{\sin\theta}\right]$$

$$E_\theta = j\,\frac{\eta\beta}{2\pi}\,\frac{I_m}{\beta}\,\frac{e^{-j\beta r}}{r}\left[\quad\checkmark\quad\right] \qquad \eta = 120\pi$$

$$E_\theta = j\,60\, I_m\,\frac{e^{-j\beta r}}{r}\left[\quad\checkmark\quad\right]$$

$$\boxed{|E_\theta| = 60\,\frac{I_m}{r}\left[\frac{\cos\left(\frac{\beta l}{2}\cos\theta\right) - \cos\frac{\beta l}{2}}{\sin\theta}\right]} \Longrightarrow \text{مهم}$$

الصوره الكامل لدى long dipole لو مطلوش الاثبات دي محفوظة

مثال

Special Case $\frac{\lambda}{2}$ dipole and $\frac{\lambda}{2}$ MonPole

* $l = \frac{\lambda}{2}$ dipole

Sub in (1)

$$\frac{\beta l}{2} = \frac{2\pi}{\lambda} \cdot \frac{1}{2} \cdot \frac{\lambda}{2} = \frac{\pi}{2}$$

$$\cos\left(\frac{\beta l}{2}\right) = \cos\left(\frac{\pi}{2}\right) = 0$$

$$\boxed{|E_\theta| = 60 \frac{I_m}{r}\left[\frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta}\right]} \quad \#$$

$$|H_\phi| = \frac{1}{\eta}|E_\theta|$$

$$\boxed{|H_\phi| = 60 \frac{I_m}{\eta r}\left[\frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta}\right]} \quad \#$$

$$\bar{P}_{av} = \frac{1}{2\eta}|E_\theta|^2 = \frac{1}{2\underbrace{\eta}_{120\pi}} \frac{60^2 I_m^2}{r^2}\left[\frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta}\right]^2 \text{ W/m}^2$$

$$\boxed{\bar{P}_{av} = \frac{15}{\pi}\frac{I_m^2}{r^2}\left[\frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta}\right]^2} \quad \text{W/m}^2 \quad \#$$

$$W_{rad} = \int_0^{2\pi}\int_0^{\pi} \bar{P}_{av} \cdot r^2 \sin\theta \, d\theta \, d\phi$$

$$W_{rad} = \int_0^{2\pi}\int_0^{\pi} \frac{15}{\pi} I_m^2 \frac{\left(\cos\frac{\pi}{2}\cos\theta\right)^2}{\sin} \, d\theta \, d\varphi$$

$$W_{rad} = 2\cancel{\pi} \frac{15}{\cancel{\pi}} I_m^2 \int_0^{2\pi} \frac{\cos\frac{\pi}{2}\cos\theta}{\sin\theta} \, d\theta \rightarrow 1.2186$$

$$\therefore W_{rad} = 30 \cancel{\times} 1.2186 \, I_m^2$$

$$\boxed{W_{rad} = 36.558 \, I_m^2}$$

Watt $\Rightarrow R_{rad} = \dfrac{W_{rad}}{I_{rms}^2}$

$$\boxed{W_{rad_{mono}} = \frac{36.558}{2} \, I_m^2}$$

Peak value

وكل المعاملات تقسيم على 2

2 * Directivity

$2 I_{rms}^2$

$$\boxed{I_{rms}^2 = \frac{I_m^2}{2}}$$

$$R_{rad_{dipole}} = \frac{36.558 * I_m^2}{I_m^2/2} = 2 * 36.558 = 73\,\Omega$$

Pure resistance

$$\boxed{R_{rad_{dipole}} = 73\,\Omega}$$

$$R_{rad_{mono}} = 36.558\,\Omega$$

Directivity

$$D = 4\pi \frac{U_{max}}{W_{rad}}$$

$\rightarrow$ (1)

$$U = r^2 \bar{P}_{av} = \frac{15}{\pi} I_m^2 \left[\frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta} \right]^2$$

$$U_{max} = \frac{15}{\pi} I_m^2$$

$$D = 4\cancel{\pi} \frac{15}{\cancel{\pi}} \cancel{I_m^2} \frac{1}{36.558 \cancel{I_m^2}}$$

$$D = \frac{4 * 15}{36.558} = 1.64$$

$$\boxed{D = 1.64}$$

$$D_{long} > D_{short,\ infintismal}$$

as The antenna length
or area increase, The direcTiviTy increase

كلما اما الحجم يزيد كلما ال D تزداد

$$D_{MonPole} = 2 * D = 3.28$$

$$\boxed{D_{Mono\ Pole} = 3.28} \ \#$$